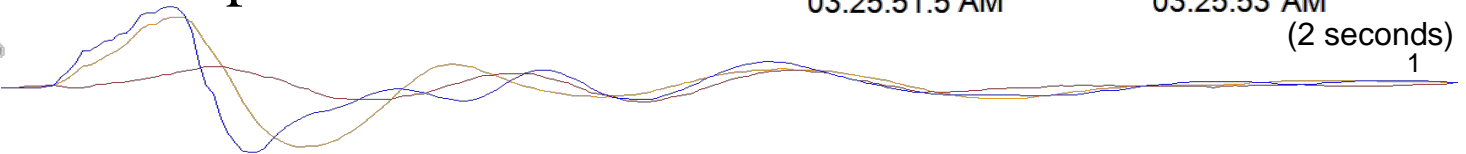
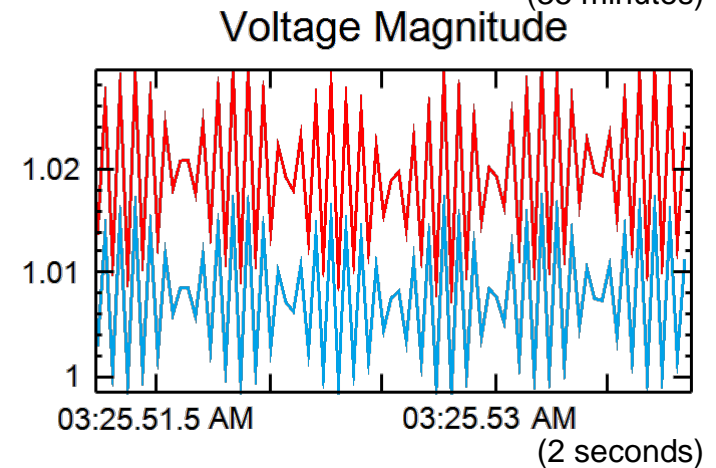
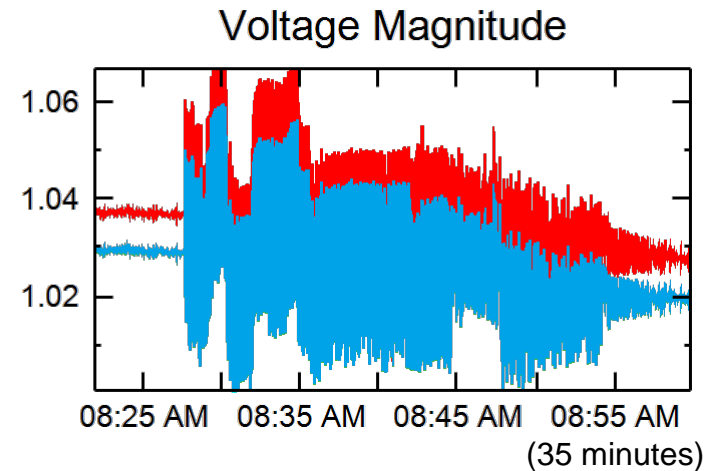
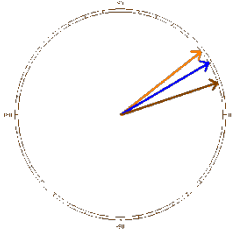


# Wind Farm Oscillations

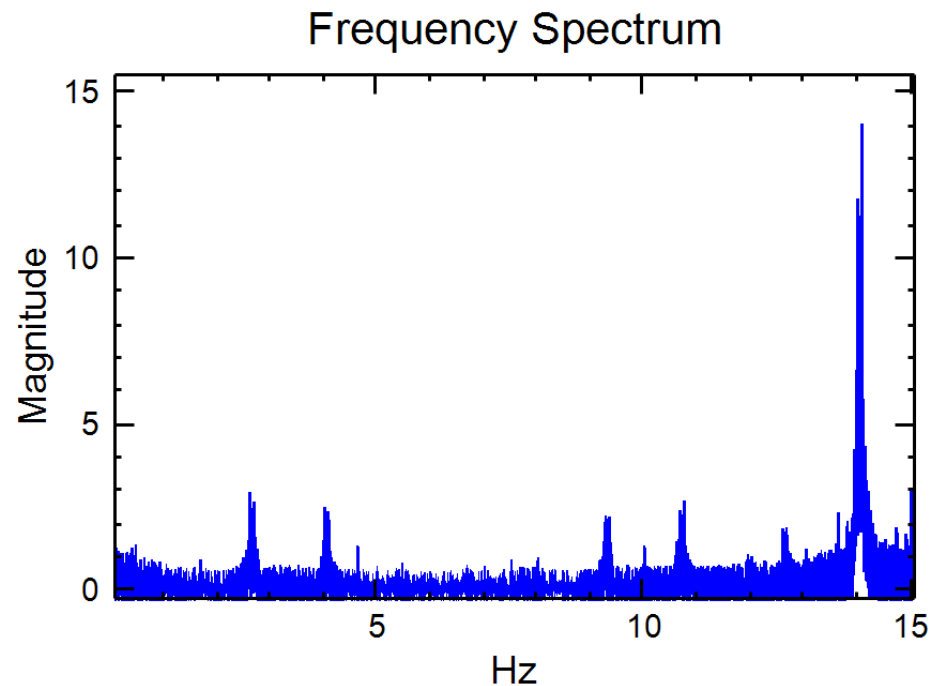
- ❑ Only during high winds
- ❑ FFT analysis shows 12-14Hz
- ❑ Voltage fluctuations as high as 5%
- ❑ Determined it is a problem at different wind farms with the same turbine model
- ❑ Manufacturer has resolved the problem with new converter parameters
- ❑ Some turbines were reverting back to default parameters

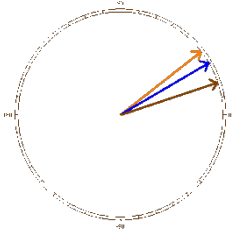




# FFT Detection Program

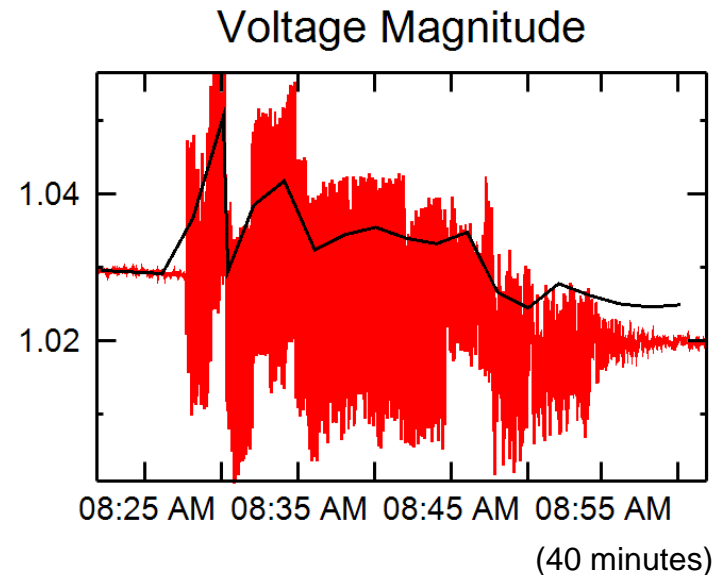
- Performs an FFT on a sliding window of 256 samples
- Sends email or text message when the oscillations reach an objectionable level
- Almost 8 hours of oscillations detected

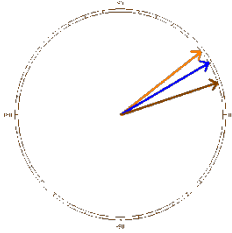




# SCADA vs Synchrophasors

- ❑ Black trace shows the voltage magnitude reported by SCADA
- ❑ Red trace shows the synchrophasor data
- ❑ The oscillations are obviously undetectable with SCADA





# Oscillation/LVRT Event of 12/14

- ❑ One line was out of service for maintenance
- ❑ Fault on another line started the oscillations
- ❑ Voltage pull-down was about 80% for 5 cycles (normal clearing time)
- ❑ Wind farm closest to the disturbance lost 57MW
- ❑ Why didn't the LVRT function properly at this facility?

